A Review of Existing Megasites and an Identification of Factors Contributing to Success and Failure

Louisiana Petrochemical Megasite Study Part 1

A Report for

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Executive Summary

Origin of the Louisiana Petrochemical Megasite Project

The Louisiana Petrochemical Megasite Project is an initiative funded by Louisiana Economic Development. This project is being undertaken by the Center for Business and Information Technologies (CBIT) at the University of Louisiana. This report is the first of four reports this year that are designed to lay the foundations for a State initiative establishing a Louisiana Petrochemical Megasite. The Report presents the factors fostering and obstructing Megasite success in the petrochemical industry. It elaborates on the definition of a petrochemical Megasite to present an ideal site and presents the metrics that would measure such success.

Megasite – A Definition

A Petrochemical Megasite is an integrated regional network of supply chains consisting of suppliers, manufacturers, distributors, support services and infrastructure providers collaborating together. This collaboration is facilitated by government investment, regulatory and revenue activities. The synergies produced by these public private/ partnerships have born fruit in improved operations, investment, management and strategy in Megasites around the world. These sites can evolve organically or be centrally planned. They can be built on green fields or be brown field redevelopments. Many have succeeded and many have failed.

Success and Failure Factors for Megasites

Based on our studies of selected petrochemical Megasites and the preliminary returns on a survey of Louisiana joint ventures, the following key factors characterize successful sites: excellent logistics, strong specialized infrastructure and support services, consistent clear policies, access to competitively priced feed stocks, access to large markets, diversified product lines, and governmental support. In today's competitive world market, the lack of even one of these factors hinders development. The following report provides the support for these conclusions and also illustrates the ways that world class sites have overcome or made the most of their situations.

A Review of Existing Megasites and an Identification of Factors Contributing to Success and Failure

Louisiana Petrochemical Megasite Study Part 1

Introduction

To establish a Megasite, it is necessary to identify the key factors contributing to its successful operations. For the purpose of clarity and consistency, the report first provides the definition of a Megasite used in this study. The report then focuses on a survey of existing and proposed petrochemical Megasites (integrated manufacturing sites) worldwide to identify their success & failure drivers. The success metrics that are influenced by these drivers are then determined. The report concludes with a Megasite framework developed from the analysis of success & failure drivers that affect Megasite success metrics. The Megasite framework will guide the operations, growth and competitive positioning of the potential Megasite development.

Every Megasite is unique in its own respect, since every Megasite operates in a different environment. In this study, the research team has captured unique megasites around the world. Each is a pioneer in their own way. For example, the Shanghai Chemical Industry Park (SCIP), is arguably one of the fastest developing Megasites with its unique characteristics such as high local demand, proximity to consumers, cheap labor, etc. On another dimension, we have surveyed the Bayport Industrial District in the US that accounts for more than 45 percent of the base petrochemicals manufacturing capacity in the U.S. European megasites with their rich experience in operating from multiple locations (ChemSite), reinvigorating their existing operations (Infraserv) and interesting governance framework (Rotterdam) have also been surveyed. Additionally, the Saudi model of Al Jubail Industrial City, unique for its cost advantage in feedstocks, has been investigated. A group of less successful sites has also been examined to bring out their unique perspective.

Interestingly, these Megasites share many common success and failure drivers. These drivers help us to arrive at the "optimal" set of drivers that would lead to the success of a Megasite.

Megasite Definition

Megasite

A Petrochemical Megasite is an integrated regional network of collaborating supply chains consisting of suppliers, manufacturers, distributors, support services and infrastructure providers. This collaboration is facilitated by government investment, regulation and revenue activities. The synergies produced by these public private/ partnerships have born fruit in improved operations, investment, management and strategy in Megasites around the world. These sites can evolve organically or be centrally planned. They can be built on green fields or be brown field redevelopments. Many have succeeded and many have failed.

A Megasite is an integrated regional network of supply chains, supported by government, consisting of suppliers, manufacturers, distributors along with support services and infrastructure collaborating on operations, production, management and strategy for the transfer of products, information, knowledge, and funds.

Taxonomy

The Megasite concept is a new economic model of integrated regional supply chains using their local competitive advantage to become world-class competitors supported by regional government. Each Megasite may possess different levels of integration between its members. We classify level of integration into four distinctly levels. In each of the following levels, a Megasite is an integration of:

- Level 0: industrial plants/complexes/sites possessing single ownership.
- Level 1: industrial plants/complexes/sites possessing multiple ownership and sharing common resources and infrastructure.
- Level 2: industrial plants/complexes/sites qualifying for level 1 and possessing any form of product flow between multiple owners.
- Level 3: industrial plants/complexes/sites qualifying for level 2 and establishing supply chains ranging from short term agreements between trading partners to long-term proactive collaboration between multiple owners.

This project proposes a Level 3 approach to collaborative to site development. This collaboration would be facilitated by government and industry participation. The goal of the collaboration would be the economic development of the State of Louisiana through the prosperity of its chemical industry.

Megasite Summaries

Successes

Al Jubail Industrial City / DSM Geleen

Objective

Al-Jubail industrial city was established by the Royal Commission for Jubail and Yanbu (RCJY). The mandate of RCJY is to implement the physical and social infrastructure required for the development of Jubail and Yanbu areas as industrial cities. One of the missions of RCJY is to promote, assist, service and otherwise encourage the development of basic, downstream and light industries that would utilize the Kingdom's natural resources to produce value added products for local use and export.

Outline of the Complex

Jubail new Industrial City is Saudi Arabia's leading area for foreign joint venture capital and overall investment, capturing almost 50 per cent of the Kingdom's total investment. With a sustained annual production growth of four percent, Jubail is the world's largest converter of natural gas resources to added-value petrochemicals, representing a 6 to 7 per cent share of

the world petrochemical market. Encompassing an area of over 38.61 sq mi, Jubail new city provides world-class infrastructure serving over 146 industries.

Facts about the Complex

The Industrial City is located 62.13 miles north of Damman in the Eastern Province and just north of the old port town of Al-Jubail. With infrastructure developed to accommodate primary, secondary, support and light industries, the Royal Commission indicates that within the past 25 years, capital investment in Jubail's infrastructure has amounted to about $46 billion. This included: $11 billion for land development, utilities, roads and the industrial and commercial ports; $31 billion for the area supporting 17 primary industries, 20 secondary industries and 109 light and support industries; and finally an additional $4 billion in capital investment in the commercial and residential areas.

Levels of Integration

a. **Multiple ownership:** In addition to the Royal Commission, many of the Kingdom's other ministries also have important development responsibilities and ownership at Jubail and Yanbu. These include: the Ministry of Industry and Electricity, which licenses all manufacturing facilities; PETROMIN (General Organization for Petroleum and Minerals) which constructs and operates oil refineries and related facilities through joint ventures with foreign partners; SABIC (Saudi Basic Industries Corporation) which builds and operates petrochemical and energy-intensive industries through joint ventures with Saudi or foreign partners; and Saudi Aramco (the Saudi Arabian Oil Company) the world's largest multifaceted, vertically-integrated oil company.

b. **Sharing common resources and infrastructure:** The Royal Commission for Jubail and Yanbu (RCJY) is responsible for providing, or helping to provide, the necessary infrastructure for Jubail and Yanbu Industrial Cities. The common infrastructures that are available are Power, Desalinated Water, Sea Water Cooling, Sanitary Waste Treatment, Industrial Waste Treatment, Natural Gas, and Developed Lands. Some of the infrastructure is provided by separate entities. For example; Electricity at Jubail is provided by the Saudi Electric Company (SEC), Desalinated Water is partially provided by the Sea Water Conversion Corporation (SWCC), Natural Gas is provided by (Saudi Aramco), while Telecommunication services are provided by the Saudi Telecommunications Co. (STC). The resources that can be shared are Roads, Telecomm, Seaports (King Fahd Industrial Port), Airports, Social Services and Recreational Facilities.

c. **Product flow between partners:** Using the associated gathered gas from oil extraction, the basic concept of industrial linkages is used to produce plans which stress initial development of petroleum-based industries for producing petrochemicals, fuels and other feedstock. These outputs not only increase value-added oil exports but also provide critical raw material feedstocks for development of downstream secondary industries, including agriculture fertilizers, cement, steel and various consumer products for domestic and export markets.

Benefits to Companies due to Collocation

a. **Savings from product flow:** The region capitalizes on its cost advantage in feedstocks, which prompt additional foreign investment in the region. In 2001, feedstock available for supporting primary industry was 37.9 million cu m per day of methane, 78.39 million cu m per day of ethane and 157500 gal/hr NGL. From this feedstock supply, primary

industry production totaled 33 million tons per year (tpy) of petrochemicals, 4.1 million tpy of steel and 16 million tpy of refined products. Secondary industry production was 400,000 tpy of petrochemicals and 430,000 tpy of steel products.

b. **Technology diffusion:** Case study - DuPont Packaging and Industrial Polymers has signed a Letter of Intent (LOI) with the Saudi International Petrochemical Company to license DuPont technology and participate with other entities in a joint venture for a new 275,000 tons/yr. vinyl acetate monomer (VAM) manufacturing plant to be located in the Jubail Industrial City. DuPont will provide the technology license and technical assistance for the joint venture. The planned VAM facility will be integrated into other petrochemical facilities currently planned for the site. The Saudi International Petrochemical Company (SIPC), which is a new Saudi joint stock company capitalized at $135 million (SR500 million), plans to form joint ventures to produce and market VAM, maleic anhydride, butanediol, methanol and acetic acid from the new world-class manufacturing facility.

Problems due to Collocation and Solutions

a. **Lack of space / Reclaim land:** A factor facing the future of the Middle East petrochemical industry is the availability of land. Much of the available land, utilities and ports are currently in use. To address this, Saudi Arabia is planning Al-Jubail Park West.

b. **Scarcity of gas / Additional gas initiatives:** Due to rapid expansion in the region, ethane volumes have become scarcer. The availability of gas for feedstock use and for power generation has become a major issue. To address this, several countries, including Saudi Arabia, Qatar, Iran and Egypt, are developing additional gas initiatives.

c. **Terrorism:** While this issue is fluid and no written report can hope to be current on the subject, no discussion of Middle Eastern sites would be complete without some mention of terrorism. Saudi Arabia has gone from one of the safest countries in the Middle East to a country the U.S. State Department recommends that its citizens not visit. This political instability is a serious road block to capital investment and technology transfer. Political risk is changing by the minute while capital investments are for decades. This effectively limits private investment to fast payback projects based on raw material price advantages.

Regulations and Policies

a. **Government sponsorship:** The Royal Commission is specifically responsible for the construction and operation of basic infrastructure facilities and public services needed by industry. The Commission is governed by a Board of Directors and its Chairman reports to the Council of Ministers.

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Note: DSM, Geleen Sold to SABIC

DSM's petrochemicals business was sold to Saudi Basic Industries Corporation (SABIC). SABIC builds and operates several petrochemical and energy-intensive plants in Al-Jubail. As a result, the activities of DSM Petrochemicals in Geleen (Netherlands) and Gelsenkirchen (Germany) were transferred to SABIC with retroactive effect from 1 January 2002. The transaction involved the transfer of all shares of the companies that together formed DSM Petrochemicals (DPC), the associated DPC participations and sales activities, and the related technology positions, patents and trade names. In what could be seen as a related move a DSM plant in Louisiana was also closed recently.

As a consequence of the transaction, a total of about 2,300 DSM employees were transferred to SABIC: the DSM Petrochemicals workforce (2,060 employees, of whom 1,530 are based in Geleen and 530 in Gelsenkirchen), plus a total of 220 people from other DSM units who worked exclusively for DPC. In 2001, DSM Petrochemicals posted sales of $ 2.89 billion. The company annually sold about 2.6 million tones of polymers, mainly in Europe. At Geleen, DSM and SABIC have mutual interdependencies in regards to the supply of feedstocks and products and the provision of services and utilities.

Bayport Industrial District, Bay Area, Houston

Objective

The objective of the chemical and plastics industry in the Bayport Industrial District is to develop itself into a world center for petrochemicals.

Outline of the District

Bayport Industrial District is a world center for petrochemicals representing more than 45 percent of the base petrochemicals manufacturing capacity in the U.S. Some of the companies in the Bay area include Air Liquide America, ATOFINA Petrochemicals, Baker Petrolite Corp., E.I. Du Pont de Nemours & Co., Haldor Topsoe, Inc., Lonzagroup, among others.

Facts about the District

Much of the activity of the district is centered in the Houston Ship Channel with a strong focus in the Bayport Industrial District. This district covers about 12 square miles.

Levels of Integration

a. **Multiple ownership:** Bayport Industrial District is with more than 340 manufacturing plants and aggregate employment of more than 37,000. There are more than 60 international companies.

b. **Sharing common resources and infrastructure:** The plants located in the industrial district share the following:

   i. Water & Wastewater

   ii. Rail

   iii. Highway Access

   iv. Common Utilities (Chemical and Others)

c. **Product flow between partners:** Chemical and plastic companies located in Bay Area Houston, have a vast array of sources for raw materials to be used in production. A multitude of feedstocks such as ethylene and propylene are available by pipeline.

Benefits to Companies due to Collocation

a. **Savings from product flow:** Chemical capacities are integrated with large refineries or upstream gas processing facilities, thereby earning savings through product flow. Case Study - ExxonMobil: Petroleum integration provides feedstock and fuel flexibility that allows ExxonMobil to outperform competition.

b. **Technology diffusion:** New technologies help industries in the district to get the most from asset base, invest efficiently for future growth, maximize the value of product mix and develop new products. Process and Catalyst Technology have greatly cut cost in the Bayport district.

Problems due to Collocation and Solutions

a. **Lack of ability to support increased demand for material transportation / Bayport Container and Cruise Terminal:** Approximately 175 million tons of cargo moved through the Port of Houston in 2002. There was increasing demand from local industries for material transportation internationally and around the United States. In January 2004, the Port of Houston Authority signed the construction permit authorizing the Bayport Container and Cruise Terminal.

Regulations and Policies

a. **Government subsidy:** The Bayport Industrial District offers two tax abatement policies for companies to utilize:

   i. Harris County Tax Abatement

   ii. Pasadena Industrial District Agreement

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ChemSite, Germany

Objective

The main aims of the ChemSite initiative are:

- To attract domestic and foreign investors to already developed chemical locations in the Emscher-Lippe region.
- To maintain and create secure jobs in this region.
- To improve the general conditions for the chemical industry as a whole in Germany and especially in North Rhine-Westphalia.

Outline of the Site

Numerous companies are operating on ChemSite locations, including international companies such as Air Liquide, Bayer Buna, BP Chemicals, ISP, Linde, PdVSA and Sasol; and existing capacities are being expanded. ChemSite locations are situated in the heart of an $8478.6bn GDP (in 2000) EU market with a population of 370m.

Facts about the Site

ChemSite has about 489 acres at six fully developed high-tech industrial sites in the Emscher-Lippe region available for investors from the chemical and chemicals-related industries. The largest area in one piece covers approximately 123 acres.

Levels of Integration

a. **Multiple ownership:** ChemSite is developed on the constructive cooperation between powerful partners from commerce (Examples: Degussa AG, BP Refining & Petrochemicals GmbH), politics (Examples: Economic Development Corporation NRW, The Münster Chamber of Industry and Commerce) and unions.

b. **Sharing common resources and infrastructure:** All sites have direct access to the European transportation networks by road, rail and waterway. There are several independent cogeneration power plants, modern waste disposal facilities, freight stations, harbor, container terminal, storage facilities and pipelines to facilitate the production at ChemSite.

c. **Product flow between partners:** The joint use of the logistical advantages of the extensive materials flow system exists at the ChemSite locations. Four of the locations are fully equipped with a comprehensive materials flow system ("Verbund"), at and between the sites for supply and disposal of products.

Benefits to Companies due to Collocation

a. **Product specialization:** ChemSite offers six different sites in close proximity. Each site has a specific production focus. Refinery, crackers and petrochemical operations are carried out at the Veba Oel sites in Gelsenkirchen, while the Marl Chemical Park focuses on base and specialty chemicals. Specialty aromatic chemicals and carbon products, on the other hand, are produced at the RUTGERS Chemicals site in Castrop-Rauxel. Processing companies can utilize greenfield space at the STEAG site in Dorsten/Marl, while a further harbor operation site of Veba Oel is located in Bottrop.

b. **Savings from product flow:** The availability of raw materials and its flow is a major advantage at ChemSite. The Marl Chemical Park is one of the largest chemical clusters in Germany. During 1997, a study was carried out and the cost was calculated for savings in interlinked cluster compared with having the park split into eight smaller and independent sites, each with nine production plants. It was estimated that the cost savings were in the region of about $ 154m or $ 43.5/tonne of product.

Problems due to Collocation and Solutions

a. **High Taxes / Match investment strategy to lowest tax rates:** Taxes in Germany are very high. ChemSite in partnership with KPMG has developed a solution that allows each investor's individual investment strategies to be tailored to avail of the lowest possible tax rate. Preliminary results indicate that this approach has resulted in tax rates lower than those in the U.S.

b. **Rigid labor laws / Temporary employment pool:** Labor laws are too rigid and worker flexibility is low. With ChemSite there is an established temporary employment pool at the Marl Chemical Park. New investors can get the highly trained employees they need when they need them, and just give them back when they are no longer needed.

c. **High labor costs / Intermediary council:** German labor costs are too high. There is an agreement with the chemical industry union that new investors may pay below standard wages. The Marl works council is committed to preventing any new project from failing due to wage negotiations.

d. **Bureaucratic Regulations / Links with the district government:** Germany has too many regulations. ChemSite has established very good links with the district government at Minister, which handles all plant permits in this area. The approval process is very fast, which means that a project's duration is determined solely by the engineering and actual building of a plant. Approval time is not a factor.

Regulations and Policies

a. **Government subsidy:** Subsidies are available through the Federal State of North Rhine-Westphalia/Germany and the European Union to the plants at ChemSite.

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Frankfurt-Hoechst Industrial Park

Objective

The objective of the Frankfurt-Hoechst Industrial Park is to develop the location into an efficient, internationally competitive site for research, development and production.

Outline of the Complex

Situated at the heart of the Rhine-Main area, the Hoechst Industrial Park affords convenient access to all major traffic carriers. The investment in the industrial park over the past year alone was around $ 471 million. There are 22,000 employees and out of them, around 4,000 work in the area of research and development. Over 75 chemical, life sciences and biotech companies are based on site – ranging from start – up to multinational companies.

Facts about the Complex

Investments by the resident companies at the Frankfurt-Hoechst Industrial Park in the last 5 years (1999-2003) are approximately $ 2.11 billion. Pharmaceuticals, basic and specialty chemicals, food additives, pigments, plastics, and crop protection products and many other finished and semi-finished goods are developed, produced, marketed and shipped from this location. The total volume of goods handled annually is circa 2 million metric tons.

Infraserv GmbH & Co. Hoechst KG offers six thousand and one services to the potential investors and companies located at the park. Energy supply, waste disposal, facility management, site management, technical, maintenance, logistics, education and training, health and safety, environmental protection, mobility, renting, hiring, leasing, etc are the services that are offered to the companies situated in the park.

Levels of Integration

a. **Multiple ownership:** There are 80 big and small companies on a total area of 1136.7 acres at the park. Aventis Pharma Deutschland GmbH, Bayer CropScience GmbH, Degussa Bank, Hoechst AG, Hoechst AG, Provadis, Siemens Axiva GmbH & Co. KG are some of the companies located at the park.

b. **Sharing common resources and infrastructure:** The Park has a Trimodal Port (rail - road - water). Piplelines running at the park are about 497.1 miles long. The on-site road network is about 44.7 miles and the on-site railway network is about 35.4 miles. More than 250 raw materials and processing media (steam, gas, cooling water, etc) are available.

c. **Product flow between partners:** From research and development, up to production and distribution: At the Frankfurt-Hoechst site, the chemical- pharmaceutical industry's entire value chain are supported by means of tailor-made service packages by Infraserv. Companies located in the Industrial Park Frankfurt-Hoechst use the existing piping and supply infrastructure. The composite structure at the site also offers special raw materials

and semi-finished goods that producing and manufacturing companies can incorporate into their processes.

Benefits to Companies due to Collocation

a. **Core Business Focus:** Infraserv GmbH & Co. Hoechst KG tries to capture what the industries located at the park need, and supports these companies with "best practice" solutions. This enables the collocating companies to concentrate fully on their respective core business.

b. **Access to well-established infrastructure:** The Frankfurt Hoechst Industrial Park is an industrial site with a long evolution; its history goes back over 140 years. Historical benefit of being located in a major economic and financial center offers investing companies cheap raw materials, a highly qualified workforce, waste disposal facilities, and utilities and other energy sources. InfraServ offers access to Hoechst's research and development center at the site, as well as the expertise of an engineering department for basic design work.

Problems due to Collocation and Solutions

a. **High Taxes / Allowances for accelerated depreciation:** Taxes in Germany are very high. Though the taxes have been reduced, they are still higher than in some other countries, but allowances for accelerated depreciation can cut down the tax bill.

b. **Approval processes / Existing ties:** Approval processes have also been speeded up, and new tenants benefit from Infraserv's existing ties to the appropriate agencies.

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Jurong Island Petrochemical Complex, Singapore

Objective

The objective of the Jurong Island Petrochemical Complex is to develop Jurong Island into a world-class chemical hub in the Asia-Pacific region.

Outline of the Complex

Jurong Island is home to leading petrochemical companies like BASF, BP, Celanese, ExxonMobil, Dupont, Mitsui Chemicals, Chevron Oronite, Shell and Sumitomo Chemical.

Facts about the Complex

Currently, the output of the chemical industry stands at $ 16.8 billion, with investment commitments of $1.1 billion Fixed Asset Investment.

Levels of Integration

a. **Multiple ownership:** There are 72 companies investing close to $ 12.8 billion in oil refining, petrochemical manufacturing and specialty chemical manufacturing and supporting facilities on Jurong Island.

b. **Sharing common resources and infrastructure:** Marine facilities, such as jetties and other berthing facilities; services such as warehousing, waste treatment, fire fighting, medical and emergency response; a common service corridor and infrastructure such as roads and drains are shared among the industries.

c. **Product flow between partners:** Output of a plant is used as feedstock by other Chemical plants (of the same owner) or sold to neighboring facilities owned by other companies.

Benefits to Companies due to Collocation

a. **Reduced Transportation Cost:** Collocating in Jurong Island is reported to have saved companies 10-15% of their total logistics costs.

b. **Savings from product flow:** Case study - Synergy was an important factor that led to Chevron Oronite locating its Oronite Asia Pacific headquarters on Jurong Island. The company required over 40 different kinds of raw materials in the manufacture of its products and was able to obtain 50% to 60% of these materials within the island itself or within the region.

Problems due to Collocation and Solutions

a. **Lack of space / Reclaim land:** There was an urgency to meet the projected demand of the industry. The problem was the lack of space. In 1991, the government approved the amalgamation plan at an estimated total direct development cost of $ 4.08 billion. The idea was to reclaim the land. By the end of 2005, Jurong Island would have a total land area of 7907.5 acres - triple the size of the original land.

Regulations and Policies

a. **Government sponsorship:** The Singapore has government invested nearly $ 2.94 billion in reclamation and infrastructure development on Jurong.

b. **Environmental regulations/procedures:** The plants in the Jurong Island Complex have clearly defined Health, Safety and Environment as the top priority in their operations.

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Port of Rotterdam, Netherlands

Objective

The Port of Rotterdam's mission is to strengthen the position of the Rotterdam port and the industrial complex at the European level - now and in the long term.

Outline of the Port

The Rotterdam port and industrial zone fulfils an important role as a hub for international goods flows and as a business location for industry and logistic services. Alcoa Chemie Nederland, Borden Chemical Holland, Cabot ,Caldic Europoort, Carbon Black Nederland ,Climax Molybdenum, Cytec Industries, Domo Polypropylene, DSM Special Products, Eastman Chemical Regional HQ, Kerr-McGee Pigments (Holland) are among the chemical companies located in Rotterdam.

Facts about the Port

The direct gross added value of the port and industrial area amounts to $ 9.3 billion. The chemical companies in the port produce more than 20% of the entire added value of the Dutch chemical industry and create 12,000 direct and 50,000 indirect jobs. The port has risen to become the European methanol hub. The port has the ability to accommodate new larger methanol vessels, in addition to having developed methanol handling, storage and infrastructure capabilities. In the year 2001, 3.5m tonnes of methanol were imported into Western Europe. The change in trading patterns has significantly boosted Rotterdam's methanol business as products from Trinidad, Venezuela, Chile, and Norway, accounts for 80% of the port's methanol imports.

Levels of Integration:

a. **Multiple ownership:** The Port of Rotterdam has four world-scale oil refineries and more than 40 chemical and petrochemical companies. Three producers of industrial gases have set up operations in Rotterdam, as well as 13 major tank storage and distribution companies.

b. **Sharing common resources and infrastructure:** Oil and chemical companies have opted for Rotterdam because of benefits derived by sharing of infrastructure and common resources by multiple owners such as extensive storage facilities to road, rail and pipeline networks and ready availability of energy, industrial gases and waste treatment facilities.

c. **Product flow between partners:** Many of the companies supply feedstocks and intermediate (semi-finished) products to their neighbors. Often, the waste streams of one company serve as raw materials for another company. The many possibilities for creating synergy have resulted in a highly efficient, low-cost operating climate for all of the chemical companies active in the Rotterdam cluster.

Benefits to Companies due to Collocation

a. **Savings from product flow:** One of the concepts which have proved to be highly successful at Rotterdam is collocation. A new company sets up its operations on or next to the industrial site of an existing company, making it possible to realize significant operational synergies and substantial cost reductions. Collocation at Rotterdam has created true win-win situations.

b. **Reduction in upfront investment costs:** The build-up of manufacturing activity has resulted in a spurt of utility and logistics providers. Various service providers offer chemical operators in Rotterdam a wide range of utilities (Electricity, Water, Natural gas, Industrial gas) and services. Service companies invest in new facilities on behalf of the chemical investor. For new parties investing in chemicals, this can mean a substantial reduction in upfront investment costs. Practice has proven that in Rotterdam, cost-reductions as high as 20-40% of the total original investment costs are possible.

Problems due to Collocation and Solutions

a. **Need for more pipelines (interconnectivity) in northwest Europe / Projects:** Pipelines get trucks and barges off the road and water and are safe and environmentally friendly. Also, they are very cost-effective over short distances and ensure an uninterruptible supply. This fact opened the need to interconnect northwest Europe since there is scope to improve on the connectivity. RMPM is keen to take part in the European common carrier propylene pipeline project (EPDC), to add to the Dow Chemical and Shell pipelines already connecting the Port of Rotterdam to other areas of northwest Europe.

b. **Less competition in water supply:** Currently, Water Company Europort and AVR are the two main providers of water of varying quality. RMPM would like to see more competition in the area of raw water supply to improve and standardize the quality of raw water supply.

Regulations and Policies

a. **Government subsidy:** A majority of chemical operators in Rotterdam consider the legislation to be "strict, but transparent and fair". Strict: high priority is given to protecting the environment; transparent: no hidden agenda; fair: chemical operators can run their businesses responsibly without having to face unnecessary obstacles or undue financial penalties.

References

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Shanghai Chemical Industry Park (SCIP)

Objective

The objective of the SCIP is to be one of the largest and the most integrated and advanced world petrochemical bases in Asia.

Outline of the Complex

SCIPAC (Shanghai Chemical Industry Park Administration Committee) is the organization authorized by Shanghai Municipality, taking responsibility for the comprehensive administration of SCIP. SCIPDC (Shanghai Chemical Industry Park Development Co., Ltd.) is the responsible subject of SCIP on the development and construction. The company, with a total capital of $ 286 million, is a multi-investor enterprise jointly established by China's state and local enterprises. It is jointly invested by SINOPEC Shanghai Petrochemical Company Limited (38.26% shares), Shanghai Hua Yi (Group) Company (38.26% shares), Shanghai Gao Qiao Petro-Chemical Corporation (11.74% shares), Shanghai Industrial Investment (Group) Co., Ltd. (7.17% shares), Shanghai International Holding Co.,Ltd (2.95% shares) and Shanghai Jiu Shi Corporation (1.62% shares).

Facts about the Complex

SCIP, located on the north bank of Hong Zhou Bay, with a total proposed area of 11.35 square miles, is one of the largest industrial investment items in China during the period of "the Tenth-Five-Years Plan". The phase I project of the SCIP covers an area of 3.86 square miles with an investment of $ 18.12 billion, and is mainly for the development of petrochemical and natural gas chemical projects. The phase II project covers an area of 5.34 square miles and is mainly for the development of new synthetic materials, fine chemicals and other petrochemical severity processing projects. The industrial output of SCIP will achieve $ 12.08 billion after all approved projects have gone into operation.

Levels of Integration

a. **Multiple ownership:** Up till now, BP, BASF, Bayer, Huntsman, Air Products and Chemicals, Ltd., SUEZ, Vopak, AIR LIQUIDE , Praxair and other world-famous multinational petrochemical and utilities corporations have started up their projects in SCIP with an aggregate investment of over $8 billion.

b. **Sharing common resources and infrastructure:** SCIP is adjacent to the A4 expressway connecting Shanghai city center to Shanghai-Nanjing and Shanghai-Hangzhou Expressway network. A feeder railway, 70.2 miles long, exclusively for SCIP, connects

Fengxian-Pudong Airport and Zhangmiao. SCIP joins to the Huangpu River and Changjiang River water system through dredged inland water transport system. Apart from the existing jetty, SCIP is only 55km away from the Yang Shan Deep Water Port still under construction and only 50km away from Pudong International Airport (10million TEU) and Hongqiao International Airport respectively, SCIP, boasts that its convenient transportation by sea, by land and by air, will provide investors in the Park with best transportation services.

c. **Product flow between partners:** Case Study - On March. 2, 2004, the largest PVC project in China started its site work at C3 block in Shanghai Chemical Industry Park (SCIP). Co-invested by Shanghai Tianyuan Group, Shanghai Chlor-Alkali Chemical Co.,Ltd and Shanghai Coking with capacity of 300,000t/a, Shanghai Caustic Soda , the PVC project's first phase is expected to complete by the end of 2005 and start operation in the first half of 2006. As the supporting project for 900,000t/a ethylene cracker, the caustic soda and PVC project works both as the consumer of upstream SECCO ethylene products and as the supplier of chlorine for a BASF MDI/TDI project. Meanwhile, it also makes use of the byproduct in a MDI/TDI plant so that integration of materials, products and reduced cost can be achieved.

Benefits to Companies due to Collocation

a. **Savings from product flow:** Case study - BASF, Huntsman and their Chinese partners – Shanghai Hua Yi (Group) Company, Sinopec Shanghai Gao Qiao Petrochemical Corporation and Shanghai Chloro-Alkali Chemical Co., Ltd. – have received approval from the Chinese authorities to optimize their planned integrated isocyanates complex at the Shanghai Chemical Industry Park to world-scale capacity. The capacity of crude MDI (diphenylmethane diisocyanate) will be increased from 160,000 to 240,000 metric tons per year and the capacity of TDI (toluene diisocyanate) from 130,000 to 160,000 metric tons per year.

b. **Abundant Human Resources:** Companies collocated in Shanghai have access to an enormous human resource market. In Shanghai, there are a total of 1,410,000 professional technicians, 210,000 professionals engaged in scientific and technical activities and 107 academicians of China Academy of Science and China Academy of Engineering.

c. **Convenient Financing:** Banks and securities transaction branches are found at Shanghai. A financial system, mainly composed of state-owned commercial banks and featured by coexistence and joint development of various Chinese and foreign financial institutions, has come into being at Shanghai. This will ease financing to potential investors.

d. **Integration of Utilities Service:** A Utilities package "island" integrating the supply of water, electricity, heat and gas is highly efficient in providing at low costs a wide scope of services including domestic water, industrial water, wastewater treatment, co-gen, jetty, tankfarm and industrial gas.

Problems due to Collocation and Solutions

a. **Lack of space / Reclaim land:** There was a need for space. Reclaiming the land was the solution. Shanghai Chemical Industry Park on Jan.18 completed the reclamation of land from Hangzhou Bay on East China Sea as part of its second phase development. The reclamation, involving a total investment of $ 81.93 million, started late last July. But

the overall reclamation work for is scheduled to be completed in the first half of 2005. The newly reclaimed land will be the site for an ethylene plant whose annual production capacity will be 1 million tons and an oil refinery which can refine 10 million tons of oil annually.

Regulations and Policies

a. **Government sponsorship:** China Petrochemical Corporation, the sole initiator of China Petroleum & Chemical Corporation (Sinopec Corp. – holding 38.26% shares in SCIP) is a state-authorized investment vehicle in the oil and petrochemical business, integrating the upstream and downstream assets. China Petrochemical Corporation is 100% owned by the state and a state-authorized investment institution and state holding company.

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Failures

India

Situation

In the mid-1990s several mega petrochemical projects were announced in India. The falling price of naphtha in the international markets and the expected increase in the local demand for petrochemicals prompted the existing players to take on large exposure in this sector.

Task

State Industrial Development Corporations of Karnataka, Tamil Nadu, Punjab, Kerala and West Bengal announced their intentions to set up mega petrochemicals complexes in the joint sector. These mega projects were expected to induce further investment in the downstream projects.

Action

The State Industrial Development Corporations started to explore their opportunities to set up mega petrochemicals complexes.

Result

However, a sharp increase in the international prices of naphtha and mass dumping by the South Asian and Gulf-based companies in the recent years made most of these projects non-viable. As a result six projects entailing $ 3.4 billion were shelved. The $ 1.6 billion project of Bharat Petroleum was the largest one amongst the shelved projects. This also affected the

prospects of the mega petrochemical projects announced by Punjab, Kerala and Tamil Nadu governments. Till date, these projects have failed to attract private partners.

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Mexico

Situation

Investment in Mexico's secondary petrochemicals market, the portion of the downstream product cycle open to the private sector, has been stagnant for several years.

Task

The task was to rekindle interest Mexico's petrochemical industry. Investors have anticipated a greater privatization of natural gas transportation and distribution rights, especially in cross-border gas deliveries from the US.

Action

Mexican administrators were not able to define the liabilities and assets of the facilities up for sale, including environmental responsibilities. The post-sale linkages to the oil refineries of Petroleos Mexicanos SA (Pemex) were also not fully transparent.

Result

Prospective investors were unsure as to whether petrochemical assets would be sold as promised.

References

[1] "Mexico's Energy and petrochemical policies at the crossroads", (*db.uwaterloo.ca*) Available: http://db.uwaterloo.ca/~alopez-o/politics/mexenergy.html (Accessed: 2004, February)

Related Issues

The Louisiana Airport Authority

The Louisiana Airport Authority (LAA) is asking the state for $88 million to buy 25,000 acres of land near Donaldsonville. The purpose of this land is to construct an Intermodal airport near Donaldsonville. LAA has picked this site to build a cargo airport with links to water, rail, and highways. The airport would cover parts of Iberville, Ascension and Assumption parishes. This complex is expected to transform the state's economy. A project like this could be an ideal launching pad for locating the Megasite nearby due to the infrastructural benefits it promises. The survey of different Megasites has shown that some of the main contributing factors towards success are airport, port, rail and highways. Since the Intermodal Airport would have access to water, rail, and highways, it would facilitate the operations at the Megasite.

However, the project, expected to have private money lined up by December 2003, has failed to attract private investors. LAA has not made significant progress on the project. Different authorities and private investors still have different opinions on the implementation and ownership issues. These are the precautions that we need to be aware of in order to avoid encountering similar obstacles in our Megasite project.

The authority's list of potential investors is as follows:

a. Aeroports de Paris Groupe, owner and operator of airports in Paris and elsewhere.
b. Aeroterm, cargo operator and developer at various airports around the country.
    i. Amsterdam International Airport
    ii. Athens International Airport
c. Bechtel Enterprises/Alterra Partners Ltd, an engineer-constructor company.
d. Boh Brothers Construction, a regional marine, railroad and heavy construction firm.
e. British Airport Authority, which owns seven airports in the United Kingdom.
f. CenterPoint Properties, a major Chicago real estate firm that develops air freight parks.
    i. Chicago O'Hare International Airport
g. Copenhagen Airport A/S, one of Europe's four largest listed airport companies.
h. Fraport AG, which owns and operates Frankfurt Airport.
i. Hochtieff AirPort GmbH, developer and operator of the new Athens International Airport.
j. Johnson Brothers, a civil contracting firm.
k. Kellogg Brown & Root, an engineering and construction company.
    i. London Heathrow
l. Schiphol USA LLC, which operates Amsterdam International Airport.
m. Trammell Crow Co., a Dallas-based real-estate developer.
    i. Peoria Intermodal Railyard

References

[1] Promises, promises. (2004), *The Times Picayune*

[2] Sentell, W. (2002), *13 Developers Inquire about Airport*, The Advocate Online News

Joint Venture Survey

The research team is in the process of conducting a survey on Joint Venture experiences of various Louisiana Petrochemical companies. The survey included the following questions:

a. How many such projects have been investigated?
b. How many such projects were completed?
c. How many such projects are successful?
d. What products were involved?

e. What activities were involved?
f. What factors were influential in promoting these projects?
g. What factors hindered these projects?
h. Who would be a contact person for follow up information?

The research team distributed the Joint Venture survey to project's Industrial Advisory Board and Louisiana Chemical Association (LCA) members. Responses are still being coming in. The responses for Completed and Successful Joint Ventures are summarized below.

- Total number of responses - 19
- Total number of ongoing/investigation joint ventures - 44*
- Total number of completed joint ventures - 15
- Total number of successful joint ventures - 10
- Total number of joint ventures with unknown outcomes - 5
- Total number of failures - 0

* Many responses had more than one Ongoing/Investigation Joint Ventures

Beneficial Factors

The beneficial factors listed in the responses are presented below.

Site – Related Factors

- Integrated site services
  - Integrated site services

Operational Factors

- Commercial viability
  - Capital cost
  - Financial return
  - On site and near neighbor industrial sites need
  - Favorable commercial terms for the parties involved in JV
  - Strategic fit with business
  - Manufacturing capability
- Waste treatment/disposal
  - Availability of waste treatment facilities
- Logistics
  - Logistics
- Raw material/feedstock
  - On site raw material
- Labor

- Labor availability

Detrimental Factors

The detrimental factors listed in the responses are presented below:

Site-Related Factors

- Utilities
  - Sewage capability
  - Unavailable water source
- Clear consistent policy / strategy
  - Global strategy
  - Change in philosophy

Operational Factors

- Commercial viability
  - Natural gas and energy pricing
  - Unfavorable costs
  - Inability to meet ROI requirements
  - Capital availability
- Technology
  - Different technical specifications for different companies
  - Misalignment of operating requirements in Safety and Environmental performance
  - Different accounting systems
  - Engineering standards
- Labor
  - Labor not trained
- Waste treatment/disposal
  - HS & E issues

External Factors

- Ease of permission
  - Approval from Governmental agencies
- Government subsidies
  - High taxes compared to other states
  - Less incentive to generate more electric power than one could internally consume
- Public support

- Relationships to surrounding communities between us and our partners

Factors Promoting and Limiting Success

From the sample of megasites studied and the joint venture surveys so for received, the factors that influenced or hindered the Megasites/projects are classified into:

a. Site-related factors
b. Operational factors
c. External factors

The effects of these factors on the Megasites/projects that have been surveyed are illustrated below in Table 1. "Infrastructure" factor includes the considerations of Rail, Road, Port and Pipeline.

No.	SITE – RELATED FACTORS					OPERATIONAL FACTORS								EXTERNAL FACTORS					
	Infrastructure	Space	Utilities	Clear point of contact	Clear consistent policy / strategy	Raw materials/feedstock	Logistics	Labor	Waste treatment/disposal	Product specialization	Technology	Commercial Viability	Services	Environmental regulations / procedures	Industry organizations	Government subsidies	Government sponsorship	Ease of permission	Public support
Al- Jubail Industrial City	✓	–	✓	–	–	✓	✓	–	✓	–	✓	–	✓	✓	–	–	–	–	–
Bayport Industrial District	✓	*	✓	–	✓	✓	✓	–	✓	–	✓	*	✓	✓	✓	✓	–	–	–
ChemSite	✓	–	✓	–	✓	✓	✓	–	✓	–	✓	–	✓	✓	✓	✓	–	–	–
Frankfurt-Hoechst Industrial Park	✓	–	–	✓	✓	✓	✓	–	✓	–	✓	–	✓	✓	–	–	–	*	–
Jurong Island Petrochemical Complex	✓	*	✓	–	✓	✓	✓	✓	✓	–	✓	–	✓	✓	✓	–	✓	–	–
Port of Rotterdam	✓[2]	–	✓[1]	–	✓	✓	✓	*	✓	*	✓	–	✓	✓	✓	✓	–	–	–
Shanghai Chemical Industry Park	✓	*	✓	–	✓	✓	✓	✓	✓	–	✓	–	✓	✓	✓	–	✓	–	–
India	–	–	–	–		X	–	–	–	–	–	X	–	X	–	–	–	–	–
Mexico	–	–	–	–	X	–	–	–	–	–	–	–	–	X	–	–	–	X	–

Legend:

✓ Factors that contribute to success

X Factors that contribute to failure

* Factors that have been addressed

– Factors whose information is not available / not applicable

1 All forms of Utilities except raw water supply contribute to success of Port of Rotterdam

2 All forms of Infrastructure with issues related to pipelines (addressed) contribute to success of Port of Rotterdam

Table 1: Factors Contributing to Megasites' Success and Failure

Success Metrics

The Success Metrics were developed from the reviews of various supply chain process reference models including the Supply-Chain Operations Reference-model (SCOR) [1], American Apparel Manufacturers Association (AAMA) Quick Response Apparel Business model [2], and Collaborative Planning Forecasting and Replenishment (CPFR) model [3],[4]. We then classify the success metrics into 3 categories:

Megasite Metrics

a. Value added
b. New investment synergies
c. Infrastructure development & usage
d. Reduced permit time
e. Connected infrastructure
f. Supply chain response time

Individual Firm Metrics

a. Reduced material acquisition cost
b. Reduced inventory carrying cost
c. Reduced cash-to-cash cycle time
d. Reduced transportation cost
e. Reduced response time
f. Reduced inventory
g. Reduced logistics cost

Government Metrics

a. Tax revenue (long term)
b. Spin off employment / employment
c. Developed public support
d. Environmentally safe
e. Capture synergies for new business
f. One face to the investor(public & private)

References

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Megasite Framework

From the analysis of success & failure drivers that affect Megasite success metrics, the research team developed a Megasite framework. The Megasite framework will guide the operations, growth and competitive positioning of the projects vision of Megasite development. It describes the impact of Site Related, Operational, and External factors on Megasite successes with respect to Megasite, Individual firm and Government metrics. The developed framework is illustrated in Figure 1.

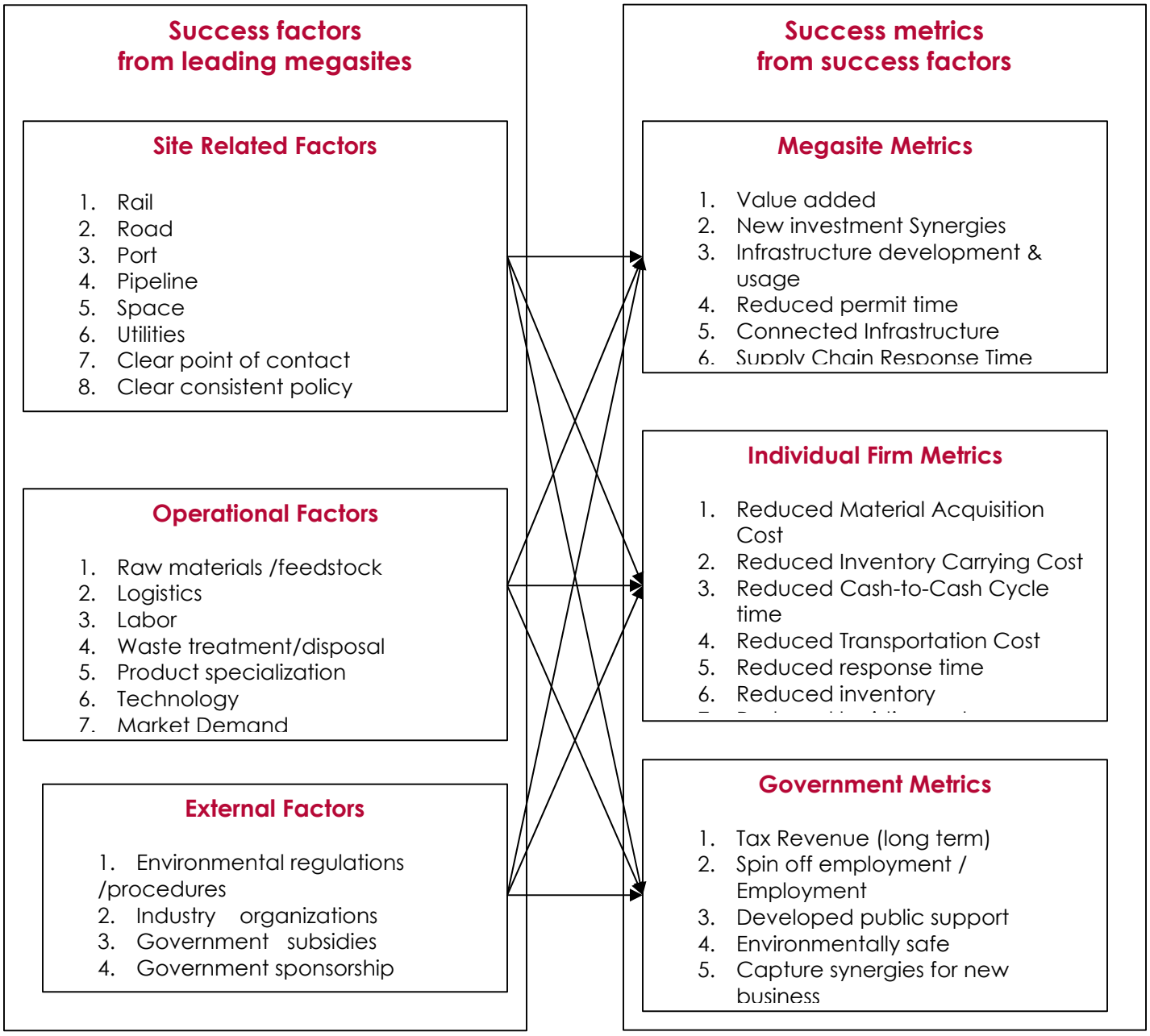

Figure 1: Megasite Factor and Metrics Framework

The Ideal Megasite

Elaborating on our original definition of a chemical megasite, and based on our research and surveys, the "ideal" Petrochemical Megasite possesses:

- Good infrastructure and support services such as specialized utilities and R&D.
- "One face to the investor" with "single window" permitting taking regulation off the critical path of development.
- Excellent logistics with competing players in the rail, truck, warehousing, and utility arenas.
- Vertically integrated supply chains that add significant value to inputs.
- High market demand and the means to flexibly respond to demand changes.
- Governmental support.
- Access to stable world market priced feedstocks.
- Economies of scale.

Of the sites surveyed, the successful European sites are the ones whose experiences are most relevant to this study. These sites share many of the strengths, weaknesses, opportunities and threats of a potential Louisiana Chemical Megasite. The Frankfurt-Hoechst Industrial Park and ChemSite initiatives in Europe have the same problems with environmental issues and public concerns that all western democracies share. They also have dealt with increasing world prices for feedstocks. They have a longer history of chemical production than Louisiana and so can lead the way in examples of how to make the most of the existing established infrastructure and the availability of brown field sites. There service management and administrative structures are of particular interest to this project. They are not built based on low gas prices like the sites in Saudi Arabia or on explosive demand as in Asia. The European sites also represent a level of governmental involvement that is greater than that in Houston but not yet as much as in authoritarian regimes. For these reasons the study will continue to focus on these sites as models to aspiration to for the Louisiana Chemical Megasite project.

Conclusions / Future Work

This report provided the definition of a Megasite to be used in the following reports of this ongoing project. The success & failure drivers of the existing and proposed petrochemical Megasites worldwide were investigated. The success metrics, influenced by the drivers were determined and a framework to guide the operations, growth and competitive positioning of a Megasite were proposed. Future reports will investigate the impact of the existing policy and governance frameworks and develop a preliminary policy and governance framework for Megasite Development. This report will most directly impact the "Report on the Economic Feasibility of Establishing a Louisiana Chemical Megasite". This upcoming report will use the Megasite Factor and Metrics Framework and the Ideal Megasite to both define what will be needed to create a competitive site in Louisiana and to judge whether it can be a success. We look forward to producing these further reports every few months and solicit any and all comments about this report and the direction of the project. CBIT wishes to thank the industry

group advising this project for their valuable guidance and ideas. This report incorporates the suggestions from the previous coordination meetings.

Appendix: Conversion Factors (as on 06/28/04)

1 SGD (Singapore Dollar) = 0.583020 USD (United States Dollar)

1 INR (India Rupee) = 0.0217360 USD (United States Dollar)

1 EUR (Euro) = 1.20 USD (United States Dollar)

1 CNY (China Yuan Renminbi) = 0.120821 USD (United States Dollar)

1 Kilometer = 0.6214 Mile

1 Hectare = 2.4711 Acres

1 sq. km. = 0.3861 sq. mi.

1 cubic foot (ft3) = 0.0283 cubic meters (m3)

1 bpd = 1.75 gal/hr